PERINATAL OUTCOMES IN AGINCOURT: 1995-2000

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand in partial fulfillment of the requirements for the degree of Master of Science in Medicine (Epidemiology and Biostatistics)

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Declaration

I, James Tanu Duworko, Jr. declare that this research report is my own. It is being submitted for the degree of Master of Science in Medicine (Epidemiology and Biostatistics) in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

Signature:

Date:

Dedication

This research report is dedicated to my wife, Musu, my daughters, Bedee Satta and Musu Annette; and my mothers, Monigo and Gawu. It is also dedicated to the memory of my grandparents, Kollie, Kormassa, and Domowa, who began it all. Thanks for all the love and support over the years.

Abstract

Objective: The objective is to estimate the magnitude and determinants of perinatal mortality in Agincourt, and determine whether there is a difference in perinatal mortality rate between South Africans and self-settled Mozambicans.

Design: Case-control study of 134 cases and 136 controls using longitudinal data drawn from the Agincourt dataset for the period 1995-2000

Methods: All cases were matched against a random selection of 136 controls. Odds ratios were used to assess risk, with p-values for trend where necessary. Logistic regression was used to determine independent effects of significant risk factors.

Limitations of the study: Probable under-reporting of stillbirths and early neonatal deaths.

Results: The Agincourt perinatal mortality rate is estimated as 13.4 per 1000 births (95%CI, 11.23-15.8) with an increasing trend from 1995-2000 (X^2 for trend 19.487, p-value <0.001). Delivery by a nurse attendant is a protective factor but not independently so. Multivariate analysis indicates that babies of women who never attended antenatal clinic during the index pregnancy are at higher risk of perinatal death (OR= 7.55; 95%CI, 2.03-28.05) compared to others whose mothers attended antenatal clinic at least four times. Women with history of perinatal death are at a higher risk of experiencing it again, compared with those without (OR =13.68; 95%CI, 1.43-130.82)*. The difference in perinatal mortality rate for South Africans (13.3) and former Mozambican refugees (11.8) is not statistically significant (p-value = 0.522).

Conclusion: Perinatal mortality is rising; key risk factors are non-attendance for antenatal care by mothers, and previous perinatal death. There is no significant difference in perinatal mortality rate between South Africans and self-settled Mozambicans in Agincourt.

* This is consistent with findings elsewhere that show that the most serious risk factor for perinatal death is perinatal death in the previous pregnancy, with some studies showing a sevenfold increase.

Acknowledgements

I wish to express my gratitude to the scientific managers of the Agincourt Health and Population Unit for making their data available to me for this study. I especially want to thank Prof. Stephen M. Tollman, my supervisor, for his guidance and teaching, and Dr. Mark Collinson for finding time in his busy schedule to draw up the dataset. I probably learned more about research from the guidance and corrections I received from Prof. Tollman than from the lectures during the course, and I am grateful. I also acknowledge the dedication and thoroughness of Mr. Obed Mokoena and all members of the Agincourt data collection and management team. None of this would have been possible without the specific roles each of them played. My deepest gratitude and appreciation go to the UNDP/WORLD BANK/WHO Special Programme for Research and Training in Tropical Diseases (TDR) for sponsoring me to do this.

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Definition of terms

Stillbirth: The complete expulsion from the mother of a fetus of 28 or more week's gestation, which shows no sign of life after or at birth

Early neonatal death: Death of a live-born infant who dies within the first seven completed days of life

Low birth weight: A baby with birth weight less than 2,500 grams

Perinatal mortality rate: The number of stillbirths and early neonatal deaths per 1000 deliveries in a given time period

Infant mortality rate (IMR): the number of deaths of infants under one year of age per 1000 live births in a given population

Attendant: A person who assists a woman during delivery in a professional way, whether a doctor, nurse, family member, community member, or some one else

Inter-pregnancy interval: The time lapse between the previous delivery and the start of the index pregnancy

1.0 Introduction and background

Neonatal mortality is a serious problem in low and middle income countries, where 4 million babies die every year in the neonatal period (the first 4 weeks of life); a similar number are stillborn.[33,42*] Three-quarters of neonatal deaths occur during the perinatal period, i.e., in the first seven days, with the highest number occurring during the first day of life.[33] The highest neonatal mortality rates are found in sub-Saharan Africa, thus African governments are challenged to lower these numbers if they are to meet the Millennium Development Goals.[33]

The South African government recognizes this and thus focuses its health policy towards primary health care and maternal and child health[1], with a lot of attention given to the lowering of the infant mortality rate; rightfully so, as the rate of decline of the IMR continues to fall in South Africa since 1990. The infant mortality rate is an important indicator not only of the health status of infants but also of the socioeconomic conditions under which they live. It is also a sensitive indicator of the availability of health care and how effectively it is utilized, especially perinatal care.[2] With the decline in infant mortality among developing countries worldwide since 1960 (HIV/AIDS is reversing this in many sub-Saharan African countries, including South Africa[34]); perinatal mortality has increasingly become a public health problem.[3] Perinatal mortality is associated with many factors, among them socioeconomic development like mother' s level of education and place of residence, health, obstetric history, fetal disorders, and availability and standard of health care in the community.[4,5,6]

* They are starting high because after submitting my report, I was advised to get more references from diverse sources, but by then, the other references were already in place. This resulted in the high numbers for any new ones.

With other programs both in and out of the health system competing for funding and attention, health care providers need to have clear information on the magnitude and risk factors of perinatal mortality. This is necessary if they are to optimally utilize the limited available resources for the benefit especially of rural inhabitants, whose access to quality health care is less than that of their urban counterparts.

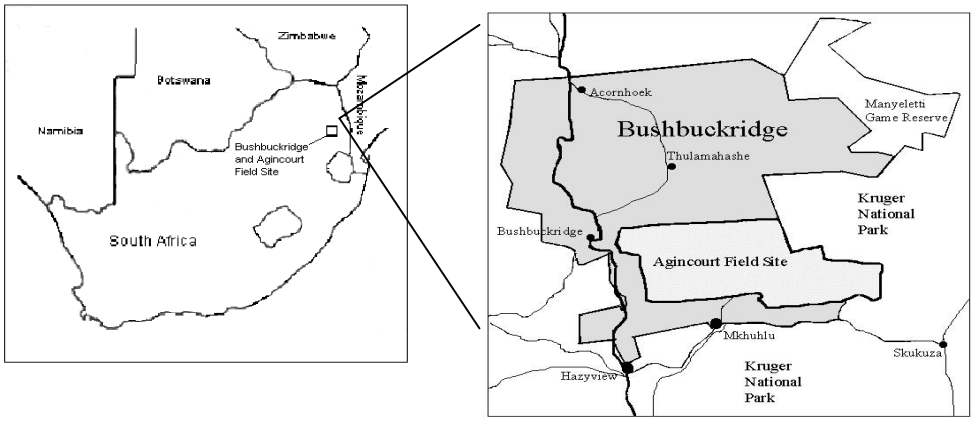
In most developing countries, there is limited epidemiological information available on perinatal mortality.[7,8,33] A recent study by South African scientists estimated the perinatal mortality in rural areas as 30.9/1000.[9] Several other studies in South Africa have also estimated perinatal mortality rate but they have all been localized, hospital-based and in urban or peri-urban areas.[10,11,12,13,41] It is therefore essential to obtain population-based estimates of perinatal mortality rate in a truly rural setting and determine its risk factors. Such knowledge can provide health planners with the basis for proper resource allocation and provide medical practitioners with the information required to make inroads in reducing perinatal mortality.

Such a task is fraught with difficulties in South African rural areas where a large proportion of births occur at home. Misclassification and under-registration are not uncommon, resulting in demographic data with important limitations.[10,33] One reliable source of data on perinatal mortality and its risk factors affecting rural populations is the household data that contain information not only about health but other socio-economic factors as well. Such information can be found at the Agincourt Health and Population Unit (Agincourt site for short) in rural Bushbuckridge, part of South Africa's Mpumalanga Province.

1.1 Study site

Research in the Agincourt site is based on a health and demographic surveillance system (HDSS), several of which have been established in developing countries around the world where data on vital events and health status may be absent or poorly organized.[14] The Agincourt site is located in the 'central lowveld', about 500km from Johannesburg, and covers a sub-district in the Bushbuckridge region of South Africa's rural northeast, near its border with Mozambique, and adjacent to the Mpumalanga and Limpopo Provinces.[15] The Agincourt sub-district has a population of about seventy thousand people, fifty thousand of whom are permanent residents living in 11,500 households in 21 villages. Two-thirds of the inhabitants are indigenous South Africans; the other third are of Mozambican origin, former refugees from that country's civil war in the 1970s and 1980s.[14]

Figure 1.1: Map showing the location of the Agincourt Field Site



The Agincourt study site was established in 1992 through a collaborative venture involving the University of the Witwatersrand and the former Gazankulu 'Homeland' and Tintswalo Health Services, as part of the Bushbuckridge demonstration district initiative.[16] Its objectives were:

i. To provide essential information on the demographic, health status and fertility status of the Agincourt community as a basis for the improved formulation, implementation, and assessment of district-level programs;

ii. To serve as a sentinel field site providing accurate information on the population dynamics of rural communities in South Africa, to inform the evolution of rural health and development policy; and

iii. To provide the capacity and database to support more advanced community-based studies and field trials in the future.

At present, Agincourt's primary objective is the provision of a field infrastructure and research platform, as well as a longitudinal database necessary for undertaking advanced community-level studies that can be used to inform decentralized health and social policy. These studies include the burden of disease, health systems implementation, and social-household-community dynamics.[14] On-going studies at the site include the Southern Africa Stroke Prevention Initiative which seeks to measure the burden of stroke on the population and the health service and investigate its causes and social context as a basis for intervening; a study funded by the South African Medical Research Council (MRC) to establish the evidence base for an effective intervention against kwashiorkor; and other studies addressing migration, violence, and the short and longer-term impacts of illness and health on household livelihoods. There is ongoing collaboration between the Agincourt Health and Population Unit and universities and research institutions in Europe, the United States and Africa. The Agincourt Health and Population Unit was awarded MRC Unit status in 2004 as the MRC/University Unit in Rural Public Health and Health Transitions Research.

A baseline census was conducted in 1992, and is repeated approximately every twelve months in order to capture demographic and social changes within the site.[14] The census information gathered includes details of household membership, and whether residents are "permanent" (resident at the site for six or more months in the preceding year) or "migrant" (resident at the site for less than six months but regarding Agincourt as home).[14]

The inhabitants of Agincourt Subdistrict are poor and live in densely populated communities (population density of 172 persons per square kilometer), with average household income estimated at R520.00* per month, most of which is spent on food.[15] Unemployment is estimated at 40-50%, with most of the employed men serving as migrant workers in mines, farms and plantations.[15] Almost all villages have a primary school, and 14 of the 21 villages have a secondary school. There is a health center and five satellite clinics, from where a restricted number of drugs are dispensed, and all are staffed by nurses. The health center has a small laboratory with the capacity to perform a limited number of diagnostic tests. An ambulance is based at the health center and all community-based services are provided free at the point of delivery.[14] Two district hospitals, each about 25km from the health center, serve as referral centers.

The area is dry and prone to drought at least one out of every three years. Water problems are of the highest priority, with households expending a lot of energy and time in fetching water for domestic use. Pit latrines are also in widespread use.[16]

* The average household income today is about triple what is was during the time of data collection for this study.

1.2 Literature review

Most perinatal deaths occur in low-income and middle-income countries, and about half occur at home.[33] In many poor communities, babies who die during the perinatal period are unnamed, and most deaths that occur during this period are unrecorded in any formal registration system.[33] For stillbirths, globally, only about 2% are accounted for in vital registration systems[48]. This poses a challenge to health policy makers and planners, as they seek to find the magnitude and risk of perinatal mortality.

A number of studies have been undertaken in several countries, and in South Africa, to measure perinatal mortality and its risk factors. [10,11,12,13,4] In a population based case-control study conducted in The Gambia, Leach et al calculated neonatal mortality at 29/1000 (early neonatal mortality at 21/1000) and found that maternal age below 18 years, (OR=1.88, 95% CI 1.33-3.15) and primiparity (OR=2.18, 95% CI 1.23-3.45) were risk factors for maternal mortality[49]. The study also showed that previous stillbirth (OR=3.19, CI 1.39-7.28), prolonged labor (OR=2.80, CI 1.25-6.29), and pre-lacteal feeding (OR=3.38, CI 1.3-3.42) were risk factors as well, for neonatal mortality.[17] A protective effect was seen in association with delivery by a trained birth attendant (OR=0.34, CI 0.17-0.70), attendance at an antenatal clinic (OR=0.17, 0.06-0.51), and the application of shea nut butter, a traditional medicine (OR=0.07, 0.02-0.32), on the cord stump,[17] presumably to prevent tetanus.*

In the Cape Verde, a similar study by Hans Wessel et al estimated perinatal rate to be 37-46/1000 total births.[18] First pregnancy (OR=2.9), previous hypertensive disease (OR= 4.2),

* In some parts of Africa, there are other risk factors, perceived or otherwise, for perinatal mortality.

previous perinatal death (OR= 4.6), pre-eclampsia (OR= 7.0), non-cephalic fetal presentation (OR= 17.1), male infant (OR= 2.1), and maternal postpartum fever (3.1) all proved significant and independently correlated with perinatal death[18]. Maternal age and parity had an increased risk but had borderline significance.[18] Lack of antenatal care was not seen as a risk factor in this study because all controls were chosen from antenatal attendees and the antenatal coverage was more than 90% of the pregnant population within the study sample.[18] However it is clear that all of these risk factors can be associated with lack of antenatal care – whether due to lack of access or poor quality – and delivery assistance.

In India, Dileep V. Mavalankar et al conducted a hospital-based surveillance and retrospective study linked with a population survey, and estimated perinatal mortality to be 79/1000.[19] This was highest among pre-term low birth weight babies. They then carried out a case-control study of stillbirths and neonatal deaths and found that poor maternal nutritional status, absence of antenatal care, and intrapartum complications were independently associated with markedly increased risks of perinatal death. Multivariate analysis showed that socioeconomic factors had no independent effect, and that they largely operated through these proximate factors.[19] They concluded that improvements in maternal nutrition and antenatal and intrapartum care could result in significant reductions of perinatal mortality.[19]

Several South African studies over the years have also found that perinatal mortality is high in areas where antenatal attendance is low, and that low birth weight, stillbirths, and neonatal deaths are common in populations of low socioeconomic status. [11,12,20] These studies found

that low birth weight, previous stillbirth, and previous neonatal death were risk factors for perinatal mortality.[11,12,20] In their study of trends in perinatal mortality at the King Edward VIII Hospital, Durban, Miriam Adhikari et al observed an increasing perinatal mortality rate, a rising stillbirth rate, and a declining neonatal death rate over the period 1984 to 1993.[13] Birth weight was found to be the most important predictor of infant mortality, and mothers at greater risk for low birth weight infants were most likely to receive little or no antenatal care. They too concluded that lack of antenatal care, poor nutrition, low socioeconomic and education status, teenage pregnancy (low maternal age), and the harmful effects of alcohol, smoking, and drug usage in pregnancy are all risk factors for low birth weight and perinatal mortality.[13]

Most of the deaths that occur during the perinatal period can be prevented by delivering interventions during recognized vulnerable points in the course of a pregnancy
and by expanding service delivery to include not only clinical care but also outreach and family-community care. This method of delivering services in "packages" has proven to be more cost effective than delivering services individually.[44,46-48] Mothers and their newborn babies receive the greatest benefits where care is available continuously from antenatal to postnatal, and from the family and community level to health facilities. During the antenatal period, interventions such as tetanus toxoid immunization and screening for other pregnancy related complications can be critical to the future survival of the neonate.

1.3 Rationale of the study

To date, it appears that most studies carried out in South Africa to determine the extent and risk factors of perinatal mortality have been hospital-based. In contrast, this study involves community-based research intended to address that information gap and provide a picture of the perinatal situation in a far rural setting, highlighting its magnitude and risk factors, based on longitudinal data collected at the household level. It is therefore hoped that the results from this study will help, firstly, the Agincourt district managers and the local health authorities to see what progress is being made at the site and what should be done to improve aspects of child health; and secondly, provincial and national planners to better understand the rural situation and what lessons can be learned and applied in other parts of the country, and perhaps other African countries as well.

1.4 Objectives

The objectives of this study are:

i. To estimate the perinatal mortality rate among inhabitants of the Agincourt subdistrict, Mpumalanga Province, South Africa

ii. To identify and quantify risk factors for perinatal mortality in the Agincourt sub-district

iii. To determine whether perinatal mortality is different between local South Africans and Mozambican immigrants living in Agincourt

iv. To make recommendations to health authorities based on the study findings.[*]

[*] This may not be a "SMART" objective, but the intention at the time was that since this study was conducted in Agincourt, Health Authorities in the area could use those findings to plan health interventions aimed at reducing perinatal and neonatal mortality.

2.0 Materials and Methods

2.1 Study sample

Research was conducted utilizing a case-control study design using data from the Agincourt health and demographic surveillance system. The study population included all babies delivered in Agincourt over a six-year period, January 1, 1995 to December 31, 2000, the records of which are stored in an SQL Server and Access 2000 relational database.

A total of 10,219 births were recorded during the six-year period. These included 99,16 live singleton births, 62 live twin births, 82 abortions, 3 twin stillbirths,[*] 88 singleton stillbirths, and 3 missing values[Ψ]. Following convention, dead fetuses resulting from pregnancies with gestational age less than 28 weeks were classified as abortions, whereas those from gestational age 28 weeks or above were classified as stillbirths.

2.1.1 Selection of cases and controls

Cases (n=134) were all perinatal deaths (stillbirths and early neonatal deaths) of singleton birth, whereas controls (n=136) were randomly chosen from all singleton births surviving the

[*] The complete expulsion from the mother of a fetus of 28 or more weeks of gestation which shows no sign of life after or at birth

[Ψ] These numbers do not seem to add up to 10,219 because the database has twin births recorded as single events, i.e., not taking into account that a birth might result into more than one outcome. So when the numbers are crunched using the software, there appears to be a disparity between the number of births and the number of outcomes. Looking at these numbers, 62 live twin births and 3 twin stillbirths amount to 65 outcomes. Adding the 65 to the outcomes leaves a deficit of 3, not the 68 as is seen in the report. The missing three could be due to other reasons. Please note, more importantly, that twin deliveries and abortions were not included in the data analysis, leaving the total number for the study as 10,004 pregnancy outcomes during the research period.

first completed seven days of life*. Twins were excluded because of the difficulty of finding matches** for them, their poor survival rate, and tendency to be of low birth weight.

2.2 Data collection in DSS sites

Data collection in Agincourt is longitudinal, based on the demographic surveillance system (DSS). DSS sites "systematically collect data (generally on fertility, mortality, and in- and out-migration) from all individuals in geographically demarcated communities."[35] Although data are collected from individuals, the actual unit of observation is the community.[35] One advantage of this method of data collection is that it allows examining of changes in behaviors and related events over time with observations close to the time of the change or event.[35] Most longitudinal community studies – such as the one in Agincourt - typically measure selected (although limited) events in much greater detail using larger sample sizes, thereby enabling better observations of many rare events.[35] It is because of these qualities that many observers suggest that research based on these data "contribute to causal relationships by collecting more accurate and detailed information on the timing and sequence of various events than might otherwise be obtainable."[35]

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* The ratio of cases to controls was about one to one (134:136)

** Ideally, live twins would be matched with dead twins, but that is difficult because some individual twins may not survive, and it was not recorded in the database which twin survived, and which lived. Therefore, finding matches among the controls for twin cases, as recorded in the database at the time, is near impossible, so I excluded them. I believe that even without them, the study provides strong epidemiological evidence for factors driving perinatal mortality in the study site.

2.2.1 Agincourt field methods

The Agincourt DSS field methods are based on the principles and activities described above. All demographic changes (vital events: migration, birth, death) that the individual experienced over the previous year as well as any status observations (education, resident status, etc.) are recorded during annual census updates.[14] Additionally, history of all pregnancies and their outcomes, maternal age, delivery dates, education level of mothers, information on road-to-health cards, maternal obstetric history, birth weights, mother's nationality, antenatal history, place of delivery, and attendant at delivery, are recorded in different data files during the annual census updates and stored electronically.

Data collection does not include clinical risk factors for perinatal deaths such as low maternal hemoglobin, birth complications (asphyxia, anoxia, etc.), maternal hypertension, or neonatal sepsis, to name a few. It would have been desirable to include these factors in this study, but this is a population based study, not a clinical study, thus the risk factors selected are limited to those available in the Agincourt DSS data set.

Each individual in the study site has a unique identification number and is regularly followed up during the annual census update. This is an ongoing process in Agincourt, and has been so since the inception of the site in 1992. Following an initial baseline census in 1992, regular updating rounds are made annually during the dry season (July –November) by the field team, which consists of 20 field workers, 4 supervisors, 4 verbal autopsy (VA) fieldworkers, and 1 VA supervisor.[14] The composition of the teams, i.e., number of

supervisors, field workers, etc., may change from time to time, but the activities remain the same for the most part.[14]

Computerized printouts of residents from the previous census round are used to check the membership status of households and gather data about residents. [14] Field workers interview the best respondent available at the time of the visit, and if appropriate respondents are absent, they undertake revisits, up to two where necessary, usually during evenings and on weekends.[14] Maternity history and pregnancy outcome questions are directed to the individuals concerned and not the principal respondent.

Given the field methods described above and the rigorous data collection system at Agincourt, it was possible to identify the great majority of all pregnancies (a few may be overlooked especially if a birth was followed by early death) and their outcomes, making it relatively easy to select cases and controls and the information needed for this study as described in this section.

2.2.2 Supervision and quality control

Field supervisors carry out supervisory visits during censuses, and revisit a 2% random sample of households and complete duplicate census forms in order to ensure data quality.[14] These duplicate forms are compared with the original interviews to ensure consistency of information and entry. During these supervised visits, supervisors accompany the fieldworkers, observe several interviews, and give constructive feedback, with the aim of improving interview technique and assuring quality.[14] More senior members of the research team carry out further form checking at four higher successive levels of the field

organization, becoming more detailed as the form progresses through the system.[14] When an error is found, it is returned to the field worker for correction, and a revisit is done where necessary. Team supervisors use the printed checklists to keep track of forms.

Known information previously collected on each household is printed on the census forms. Separate event forms are used for different events, for example, pregnancy outcomes, deaths, migrations, and maternity histories, and are only completed if they occurred during the intercensal period.[14] Death forms are completed in duplicate, with a copy going to the verbal autopsy* team to determine probable cause of death.[14]

2.2.3 Data entry

After passing all field-based quality checks, the forms are captured on an SQL Server (previously held in Microsoft Access 2000). The data for this study were captured using simultaneous data entry on three computers connected to a network, writing to a 'relational' database on a server, held in Microsoft 2000 Access.[14] The database consists of related tables storing different aspects of the data. Thus the main table is the "Individual" table, which stores information on all individuals encountered since the first census in 1992. Then there is the "Residence" table, with information on the individual residence episode on all inhabitants, and the "Membership" table, which stores information on how and when individuals entered and exited particular households.[14] Vital event categories such as deaths, births, migrations, and maternity histories are also stored in separate tables.[14]

* Relatives of the deceased are interviewed, and based on detailed description of the signs and symptoms of the deceased at the time leading up to their death, appraised by three doctors independently, the probable cause of death is determined.

2.2.4 Validation of data

Built-in validation checks are incorporated into the data entry system to prevent recording of implausible data; where this is found, the data manager reviews the data, and, if necessary, returns it to the team supervisor for resolution.[14] Computer checks are made as data are entered in order to weed out invalid codes, missing values, incorrect spellings of place names, and duplicate entries.[14] Data cleaning, followed by data analyses, are then carried out to produce reliable population data.[14]

2.3 Data cleaning and manipulation

As information about different parameters is entered into different tables (files) in the database, one has to use queries in Microsoft Access* to link tables in order to find matching records. When the table with information on babies born was linked to the one with data about pregnancies, it was discovered that 53 babies had not been provided with an identification number. To address this problem, the mothers' identification numbers were matched with their pregnancy outcomes and the delivery dates, which resulted in actual pregnancies and their outcomes, i.e., babies, whether born alive or dead. It also made it possible to determine intervals between pregnancies. Using this method, the 53 babies with missing identification numbers were included in the study. A third table, the maternity history table, with information on all past pregnancies and their outcomes, was then linked to the other two tables – pregnancies table and babies born table – in order to obtain full information on a mother's obstetric history.

* Microsoft Access is a relational database management system, a system in which data is stored in the form of tables and the relationship among data is also stored in the form of tables, making it possible to link data between tables.

The Agincourt database also included data on mother's educational status (completed years of schooling), age, place of delivery, parity, attendant at birth, outcome of the index pregnancy, whether or not the mother attended antenatal clinic, and how many times if she did. In order to obtain the inter-pregnancy interval for each mother, the mother's identification number of each case and control was used to relate the time and outcome of the previous pregnancy (recorded in the maternity history file) to the index pregnancy. The parity for each mother at the time of the index pregnancy was also determined likewise. These last two exercises (determining parity and inter-pregnancy interval) were done manually by the author without using computer commands. Other information on the database included baby's birth weight, as recorded on the road-to-health card, whether born live or dead, and sex (male or female). An attempt was made to determine from the database those cases that were referred as emergencies to the hospital but the database did not include such information. After cleaning the data, a total of 10,216 births were found, covering the six-year period.

2.4 Statistical analysis: estimation of perinatal risk

Analysis was performed using Epi Info version 6 and Intercooled Stata 7.0 statistical software packages. Crude odds ratios (OR) were estimated with 95% confidence intervals for each specified risk factor. The Chi Square for trend with p-values was calculated where appropriate, for example, perinatal mortality levels over the six-year period. In some instances, certain variables were regrouped into categories, for example, age or weight ranges, in order to achieve greater statistical power. Thus maternal age, birth weight, educational level, and antenatal visits were grouped. For example, maternal age was grouped

into age before 20 years, in order to determine the risk to perinatal mortality of teenage pregnancy, age 20 to 24 years, age 25 to 34 years, and age 35 to 50 years. All these results are displayed below in appropriately labeled tables.

2.4.1 Logistic regression*

Multiple logistic regression analysis was performed using Intercooled Stata 7.0 in order to estimate the relative contribution of the different independent variables on risk of perinatal death. All independent variables were initially included in the analysis, and step-down elimination was used to exclude those variables that were found not to be statistically significant. The goodness-of-fit test was used to determine whether those variables found to be statistically significant could explain the observations in the model. The final model included only the variables that had a significant independent influence on the risk of perinatal death.

2.5 Ethical clearance

Approval for this study was granted by the Postgraduate Committee of the Faculty of Health Sciences, University of the Witwatersrand, and the Committee for Human Subjects (Medical), which had previously granted the scientific managers of Agincourt ethical permission to conduct demographic studies in the DSS site, specifically the annual DSS update (reference No. R14/49 Tollman; protocol No. 960720; Ethics No. M110138). Since this study involved secondary data analysis using longitudinal data derived from the

* Logistic regression is a technique for analyzing problems in which there are one or more independent variables (that may be continuous, discrete, dichotomous, or a mix of any of these) which determine an outcome. Generally, the dependent or response outcome (perinatal mortality in this study) is measured with a dichotomous variable in which there are only two possible outcomes (perinatal death or not, in this study).

Agincourt database, it was not necessary to obtain informed consent from study subjects, as this was previously acquired at the time of annual census.

3.0 Results

3.1 Perinatal mortality rate

The perinatal mortality rate in Agincourt over the six-year period 1995 to 2000 was 13.4 per 1,000 births. Early neonatal deaths contributed 4.6 per 1,000, and stillbirths, 8.8 per 1,000 to this rate. The perinatal mortality rate by demographic factors is shown in Table 3.1. Seventy-six percent of deliveries included in this study occurred in health institutions (67.8% in hospitals, 5.6% in clinics, and 3% in health centers) and 22.6% occurred at home, with 1.1% occurring elsewhere. As expected, perinatal mortality is higher in males than females, although this is not statistically significant, probably due to the high number of missing values for sex of stillbirths (63 out of 88, or 71.6%) This finding is not unexpected in a rural setting where mothers often do not consider stillbirths as babies and therefore are not particular about the sex.

Factors that may have an influence on perinatal mortality were analyzed in this study and are displayed in Tables 3.1-3.5. Among these were maternal factors: age, educational level, antenatal visits, birth attendant, place of delivery, parity, nationality, previous perinatal death of child, and inter-pregnancy interval. Fetal factors were birth weight and gender.

In this study, the child's nationality is assumed to be that of the mother's. The perinatal mortality rates of 13.3 and 11.8 per 1,000 births among South Africans and Mozambicans respectively may appear different (Table 3.1), but the difference between them is not statistically significant (p-value= 0.522).

Of all deliveries in the sample study, 206 (76.3%) took place in a health facility (hospital, clinic, health center), while 64 (23.7%) occurred outside a health facility (at home or elsewhere). Delivery at home carries the highest perinatal mortality rate among places of delivery (Table 3.1), although this is not statistically different from delivery in a hospital.

Table 3.1: Perinatal mortality by demographic factors in Agincourt Sub district: 1995- 2000

Category	Stillbirths		ENDs		Total births		PMR	95% CI
	n	(%)	n	(%)	n	(%)		
Sex								
Male	10	(11)	33	(72)	4899	(49)	8.8	6.36-11.80
Female	15	(17)	12	(26)	4929	(49)	5.5	3.61-7.96
Missing	63	(72)	1	(2)	176	(2)		
Delivery place								
Hospital	54	(61)	32	(70)	6610	(66)	13.0	10.42-16.04
Clinic	3	(3)	3	(7)	524	(5)	11.5	4.21-24.75
Health center	2	(2)	0	(0)	376	(4)	5.3	0.64-19.08
Home	28	(32)	10	(22)	2336	(23)	16.3	11.54-22.26
Other*	1	(0)	1	(2)	88	(0)	22.7	2.76-79.70
Missing	0	(0)	0	(0)	70	(0)		
Nationality (mother's)								
South African	52	(59)	32	(70)	6337	(63)	13.3	10.59-16.39
Mozambican	29	(33)	14	(30)	3654	(36)	11.8	8.53-15.82
Others	0	(0)	0	(0)	6	(0)	0 -	
Missing	7	(8)	0	(0)	7	(0)		

* Delivery in a place other than those listed, in a transport car or ambulance, for example
END: early neonatal death
PMR: perinatal mortality rate

Table 3.2 displays the yearly perinatal mortality, stillbirth, and early neonatal death rates for six years, 1995-2000, demonstrating significant increases in the perinatal mortality rate (Chi square for trend 19.487, p-value <0.001). The graph (Figure 3.1) shows the changing perinatal mortality rate over the six years.

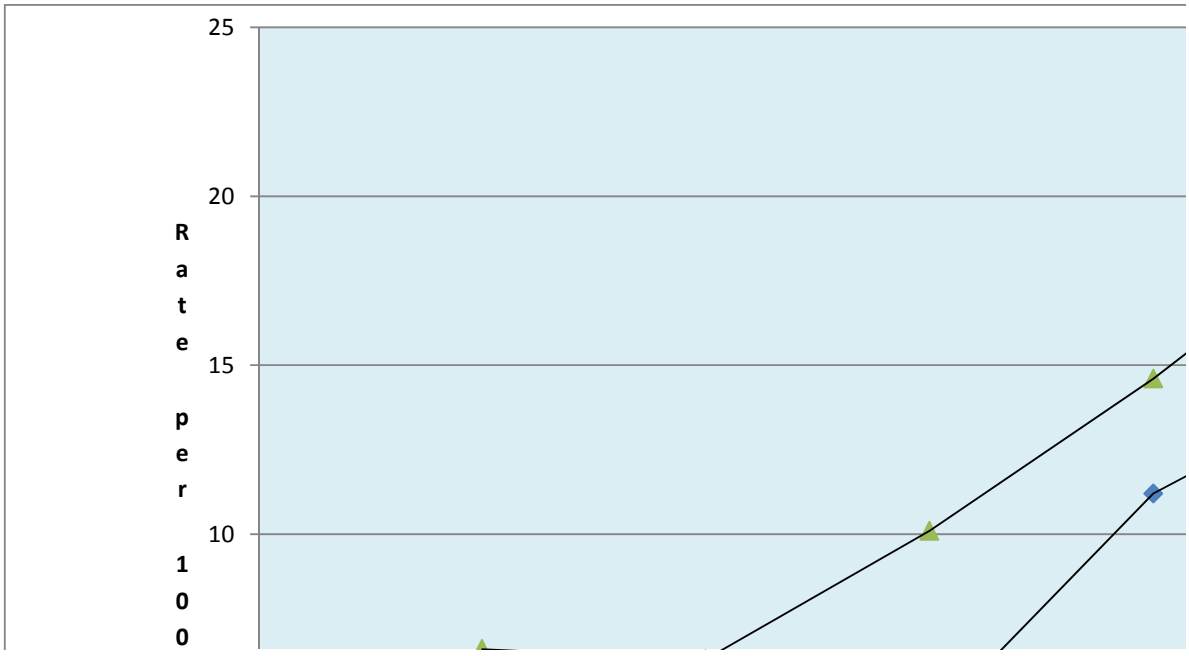
There is a sharp increase in the number of stillbirths from 1998 to 2000. It is not apparent why this is so; perhaps it is due to improved recording of, and not an actual increase in, stillbirths.

Table 3.2: Perinatal mortality rates by year in Agincourt:1995 to 2000

Year	Total birth	Stillbirths	ENDs	SB rate	END rate	PMR♦	95% CI
1995	1358	5	4	3.6	2.9	6.6	3.04-12.54
1996	1435	7	2	4.9	1.4	6.3	2.87-11.87
1997	1589	7	9	4.4	5.7	10.1	5.77-16.30
1998	1784	20	6	11.2	3.4	14.6	9.54-21.28
1999	1977	29	10	14.7	5.0	19.7	14.06-26.87
2000	1861	20	15	10.7	8.1	18.8	13.13-26.06
Total	10,004	88	46	8.8	4.6	13.4	11.23-15.8

END: Early neonatal death
PMR: Perinatal mortality rate
♦Chi square for trend: 19.487 p value<0.001

Figure 3.1: Stillbirths, perinatal, and early neonatal deaths in Agincourt: 1995-2000



3.2 Factors associated with perinatal mortality

Figure 3.1 indicates a steep rise in stillbirths in 1998. This might have been due to improved methods of data collection in Agincourt, rather than an actual increase in perinatal deaths. During the same period, there was a decrease in early neonatal deaths; perhaps due to an increase in hospital deliveries where neonatal care was much better than care at home. These figures are much lower than the facility-based rates, as recorded by the to the South African District Health Barometer of 2011/2012[50]. One contribution to this is because, anecdotally, Africans tend to not want to remember unpleasant events, especially the death of infants, and might not report it during the annual census in Agincourt. Additionally, they might misclassify stillbirth as miscarriage, resulting in under-reporting of a significant contribution to perinatal mortality rate.

Table 3.5 illustrates the distribution of selected risk factors among cases and controls (maternal, fetal, and obstetric-related), the crude and adjusted odds ratios for perinatal death, the 95% confidence intervals, and p-values. Two risk factors proved to be significantly correlated with perinatal death when multiple logistic regression was applied: lack of antenatal care (OR=7.55; 95% CI 2.03-28.05) and previous perinatal death (OR=13.68; 95% CI 1.43-130.82). The other hypothesized risk factors proved not to be independent risk factors for perinatal mortality after logistic regression in this study.

Of all the subjects in this study (Tables 3.3 and 3.5), antenatal attendance (ANC) overall, regardless of whether it was in clinic, health center, or hospital, in Agincourt was 51.9% (140 of 270). Of these 11.9% (32 of 270) attended 1 to 3 times and 40.0% (108 of 270) attended 4 or more times; 21.1% (57 of 270) did not attend at all. The antenatal attendance status was not determined for 27.0% (73 of 270) of the women. Of those who attended, 62.1% (87 of 140) were South Africans, compared with 35.0% (49 of 140) Mozambicans. The nationality of 4 attendees was missing. Among South Africans overall, 49.7% (87 of 175) accessed antenatal care, 12.0% (21 of 175) attended 1 to 3 times, 37.7% (66 of 175) attended 4 or more times, but 22.3% (39 of 175) did not attend antenatal clinic at all. For Mozambicans, 55.7% (49 of 88) accessed antenatal care overall; 12.5% (11 of 88) attended 1 to 3 times, 43.2% (38 of 88) attended 4 or more times, but 18.2% (16 of 88) did not access antenatal care at all.

This overall difference (among sample subjects) in accessing antenatal care between South Africans and Mozambicans was not statistically significant (p=0.36). Among maternal risk factors, not attending antenatal clinic was a significant risk factor for perinatal death (OR=7.55; 95% CI 2.03-28.05), and remained significant even when adjusted against other risk factors. Delivery by a nurse was a significant protective factor initially but failed to be so when adjusted for other factors. Neither mother's education (OR=0.68; 95% CI 0.34-1.36), place of delivery, or nationality significantly influenced the risk of perinatal death. Maternal ages below 20 years (OR=2.03; 95% CI 0.96-4.30) and 35 years or above (OR=1.63; 95% CI 0.71-3.71) had raised crude odds ratios for perinatal death but they were not statistically significant. This was also true of delivery by a community member

(OR=2.69; 95% CI 0.27-133.07), parity of 2 or more (OR=1.99; 95% CI 0.43-10.55), inter-pregnancy interval less than 6 months (OR=1.6; 95% CI 0.28-11.33), and male sex (OR=1.46; 95% CI 0.78-2.75).

Table 3.3: Number of antenatal visits by nationality in Agincourt Sub district: 1995-2000

No. of ANC visits	Mozambican mother*	S. African Mother	Missing	Total
0	16	39	2	57
1-3	11	21	0	32
4 or more times	38	66	4	108
Missing	23	49	1	73
Total	88	175	7	270

Fewer multiparous women 7.7% (21 of 270) than primiparous women 44.1% (119 of 270) accessed antenatal care. Only 14.1% (38 of 270) of mothers below 20 years accessed antenatal care.

A woman's educational status was not a significant factor in determining whether or not she accessed ANC services in this study (Tables 3.4 and 3.5). Among educated women, ANC attendance rate was 71.4% (115 of 161), while that of women who had never been to school was 69% (24 of 35). Of women who had never been to school, 31.4% (11 of 35) did not access antenatal care, compared with 28.0% (45 of 161) of those women who had been to school. This difference between these groups with respect to lack of antenatal care was also not statistically significant (p=0.69).

* A mother who was originally Mozambican but now a South African through naturalization

Table 3.4: Characteristics of women attending ANC in Agincourt Sub district: 1995-2000

ANC	Attended school	Never attended school	Missing	Total
Yes	115	24	1	140
No	45	11	1	57
Missing	1	0	72	73
Total	161	35	74	270

Table 3.5 illustrates the influence of various independent factors on perinatal mortality. These include maternal (age, education level, attendance at antenatal clinic, attendant at birth, place of delivery, nationality, parity, history of previous perinatal death, and inter-pregnancy interval) and fetal factors (birth weight and gender).

Table 3.5: The odds ratio of risk factors among cases (perinatal deaths) and controls in Agincourt: *1995* to 2000

Risk factor	Cases n(134)	(%)	Controls n(136)	(%)	P- value	Unadjusted[Ψ] OR	95% CI	Adjusted[Ψ] OR	95% CI
Maternal Factors									
Age (years)					0.648*				
11-19	39	(29)	25	(18)		2.03	0.96-4.30	0.97	0.28-3.40
20-24	30	(22)	39	(29)		1.00	Referent		
25-34	40	(30)	52	(38)		1.00	0.51-1.97	0.48	0.15-1.48
35+	25	(19)	20	(15)		1.63	0.71-3.71	0.81	0.20-3.23
Education (years)					0.250*				
0	24	(18)	11	(8)		1.11	0.45-2.87	0.92	0.21-4.07
Sub A-6	43	(32)	32	(24)		0.68	0.34 -1.36	1.51	0.43-5.26
6+	57	(43)	29	(21)		1.00	Referent		
Missing	10	(7)	64	(47)					
Antenatal visits					<0.001*				
0	48	(36)	9	(7)		5.74	2.45-14.52	7.55	0.3-28.05
1-3	24	(18)	8	(6)		3.23	1.25-9.01	3.53	0.83-15.09
4+	52	(39)	56	(41)		1.00	Referent		
Missing	10	(7)	63	(46)					
Birth attendant					0.766				
Doctor	29	22)	13	(10)		1.00	Referent		
Nurse	63	(47)	94	(69)		0.30	0.13-0.65	19.63	0.39-979.09
Family member	26	(19)	15	(11)		0.78	0.28-2.13		
Comm. Member	6	(4)	1	(1)		2.69	0.27-133.07	10.79	0.78-148.56
Nobody	7	(5)	7	(5)		0.45	0.11-1.86	0.91	0.24-3.51
Other	1	(1)	1	(1)		0.45	0.01-37.87		
Missing	2	(1)	5	(4)					
Delivery place					0.059				
Hospital	86	(64)	97	(71)		1.00	Referent		
H. center	2	(2)	6	(4)		0.38	0.04 –2.18	1.09	0.17-6.99
Clinic	6	(4)	9	(7)		0.75	0.21-2.48	0.10	0.01-1.57
Home	38	(28)	23	(17)		1.86	0.99-3.55	0.24	0.05-12.72
Other	2	(2)	1	(1)		2.26	0.12-134.42		
Nationality					0.999				
S. African	84	(63)	91	(67)		1.00	Referent		
Mozambican	43	(32)	45	(33)		1.04	0.60-1.78	1.14	0.40-3.29
Others	7	(5)	0						
Obstetric History					0.666*				
Parity									
0	108	(81)	117	(86)		0.81	0.36-1.83		
1	17	(13)	15	(11)		1.00	Referent		
2+	9	(7)	4	(3)		1.99	0.43-10.55	0.24	0.03-2.03
Previous perinatal death					0.012				
Yes	12	(9)	2	(1)		6.59	1.42-61.45	13.68	1.43-130.82
No	122	(91)	134	(99)		1.00	Referent		
Inter-pregnancy interval					0.712				
<= 6 months	6	(4)	3	(2)		1.60	0.28-11.33	1.88	0.15-23.26
> 6 months	20	(15)	16	(12)		1.00	Referent		
No previous Pregnancy	108	(81)	117	(86)					
Fetal factors									
Birth weight					1.000				
<2.5kg.	2	(1)	9	(7)		1.09	0.10-6.24	1.02	0.05-19.97
2.5kg. +	13	(10)	64	(47)		1.00	Referent		
Missing	119	(89)	117	(86)					
Gender					0.269				
Male	43	(32)	70	(51)		1.46	0.78-2.75	2.45	0.95-6.29
Female	27	(20)	64	(47)		1.00	Referent		
Missing	64	(48)	2	(1)					

* Chi Square for trend

Ψ The unadjusted odds ratio is a measure of the crude odds of an outcome, including confounders (age, sex, poverty level, for example), but the adjusted odds ratio excludes the effects of confounders. The outcomes change when odds ratios are adjusted, i.e., their effect on pregnancy outcomes are in conjunction with other factors (confounders). This changes when they are taken as independent variables.

4.0 Discussion

4.1 Magnitude and trend in perinatal mortality

The perinatal mortality rate estimated in this study is 13.4 per 1,000 (Table 3.2). This is considerably lower than findings from previous hospital-based estimates in rural South Africa.[13,21] Perhaps this is because cases referred to hospital are more severe maternal cases, and that they arrive late at the hospital, and therefore have a higher risk of stillbirth and early neonatal death. In any case, these studies were not community-based data, as is this study.

There appears to be an increasing trend of perinatal mortality rate over the years in Agincourt, but it is not clear whether this increase is authentic, or merely an artifact, due to less efficient data collection during the earlier years at the site, so that with improved data collection during the latter years, there appears to be an increase. If the data represents the true state of affairs, and is not just due to an improvement in data collection over the years, then this finding is similar to results obtained for clinic deliveries in the Durban Functional Region, which refers patients to the King Edward VIII Hospital.[21] It is likely that the actual situation is a mixture of the two. A closer scrutiny will reveal that this might imply a real increase in perinatal mortality rate because for the first three years of this study, the perinatal mortality rate is much less than 13.4 per 1,000.

4.1.1 The effect of HIV/AIDS

With the HIV prevalence among antenatal attenders in Limpopo Province at 11.4%[22] in 1999, it is likely that the increasing trend in perinatal mortality is associated with the rising HIV prevalence. This is more so when one considers that the first AIDS death in Agincourt was recorded in 1993, and that there has been a rapid steady increase in prevalence since then (20.7 and 32.1 for Limpopo and Mpumalanga Provinces respectively, for all ANC attendees for 2006)[51]. This would be consistent with recent investigations in Africa and elsewhere that have associated HIV/AIDS with a rise in perinatal mortality rate.[23,24] Similarly, in a systematic review and meta-analysis conducted by Peter Brocklehurst and Rebecca French on the association between maternal HIV infection and perinatal outcome, they found that stillbirth was nearly 4 times more likely in mothers with HIV infection, and that perinatal mortality was nearly 2 times as likely for mothers infected with HIV.[25] This is likely due to the unhealthy effect of HIV/AIDS infection on the constitutional status of a pregnant woman and unborn child. Additional clinical research needs to be undertaken to validate and understand this finding.

4.1.2 Perinatal mortality by nationality

The findings in this study indicate that there is no statistically significant difference in perinatal mortality rate between South Africans 13.3) and former Mozambican (11.8) refugees (p-value = 0.522). This is consistent with findings by researchers in Agincourt which showed no difference in infant mortality rates between former Mozambican refugees and South Africans[41], but is in contrast to findings elsewhere which report that refugees, often with less access to health care than nationals, tend to have poorer health indicators.[26]

What this suggests is that Agincourt and its surrounding seem to be more accommodating to the Mozambicans, in terms of access to health, than is anecdotally observed elsewhere with other refugees. It also suggests that while it may be true that refugees do indeed experience some disadvantages, the anecdotal xenophobia and other disadvantages refugees experience is not impacting adversely on perinatal outcomes in Agincourt and surroundings. An explanation for this may well be that the Agincourt refugees have self-settled over many years, and are quite well-integrated into the area, unlike refugees based in camps in times of crisis. Furthermore, Mozambicans are also entitled to access free health care as well as schools; there are also strong kinship ties, as they are mainly of the same ethnicity in spite of country of origin. In fact, more Mozambicans (55.7%) seem to access antenatal services than South Africans (49.7%), although this difference is not statistically significant (p=0.36).

4.2 Quality of data and limitations of the study

This study involves secondary data analysis using data drawn from the Agincourt dataset. Because Agincourt is a demographic surveillance system (DSS) site, the limitations explained in this section are those common to most sites, of this nature.[14] In such studies, there are limitations that exist that one would not otherwise have if this were a primary study. However, in this study, the data used for secondary analysis is taken from Agincourt's core data set which, although excellent for trend analysis and support to other studies, is limited and restricted in scope. For example, although one would like to determine the association of risk factors such as maternal hemoglobin, birth asphyxia, cephalic presentation, maternal hypertension, and the trimester during pregnancy at which times antenatal visits were made on perinatal outcomes, they are not in the dataset. Furthermore, the number of missing

values in this study would probably be less, were this study a primary clinical study or a prospective study, as opposed to a retrospective study using secondary data that relies on mothers' recollection of sometimes unpleasant events.

Other limitations to this study are those due to the nature of data collection. Because the study utilizes longitudinal household data collected once each year in Agincourt by interviewing inhabitants about demographic events that occurred in the course of the previous year, information biases are possible, due to lapses in memory by respondents either consciously or otherwise, as stillbirths and neonatal deaths are both unpleasant events. Some respondents may also not be willing to talk about these unpleasant events perhaps as a result of cultural beliefs, thus raising the possibility of their under-representation during the census by field staff, and consequent under-reporting of events. Thus, the accuracy of the data depends on the memory and cooperation of the respondent, the skill and patience of the interviewer, and the community's overall understanding (which is high in Agincourt) of the purpose of the annual census.

The nature of the information required can also affect the accuracy of the data and lead to bias. For example, a mother might be less likely to remember the sex of a stillbirth or early neonatal death that occurred, say, over 8 months prior to the interview, than she would the sex and birth weight of a child who survived. Thus it is no surprise at all that the sex for 64 of the 134 cases was not determined (recalled?) as opposed to only 2 among the control neonates (Table 3.3). Important also is that birth weight is often not recorded for stillbirths. These are some of the reasons why missing values are common in certain instances, resulting

in a decrease in sample size and thus the power of the study with regards to certain variables - birth weight, inter-pregnancy interval, and sex, for instance.

Another source of potential bias is the misclassification that might occur if cases of abortion are recorded as stillbirths. This is possible if a fetus dies in the uterus before the 28th week of gestation but is delivered after the 28th week. Such a case is likely to be misclassified as a stillbirth rather than an abortion. Conversely, misclassification of stillbirths as abortions can occur in instances in which the woman does not remember the child's gestational age at the time of the census, which may be some time after she experienced the loss of her baby.

Although the road-to-health card is often used by the fieldworkers to validate information, its usefulness is limited for stillbirths; it is used to monitor the growth, weight, and immunization status of a child, and not to provide information on dead fetuses. The road-to-health card is also limited if the delivery occurs outside of health facilities; even if one is made for the child during subsequent clinic visits, the birth weight will not be recorded . This is another reason why the birth weight and the sex variables have such large missing values. In addition, births occurring away from a health facility, especially dead births, often lead to missing values, and are likely to be accentuated in mothers/children suffering perinatal death.

Despite the limitations described above, the thoroughness and meticulousness with which data is collected and handled, the closeness of the events to the time of collection (annual census updates), and the dedication and motivation of the Agincourt staff (experienced and

observed on-site) convinced me that the results of this study are valid, and among the best for DSS sites in the world.

4.3 Factors associated with perinatal death

The findings in this study in terms of risk factors are consistent with findings from similar studies done elsewhere.[17,18,19,20] Examination of the crude odds ratio reveals several factors associated with an increased risk of perinatal mortality (Table 3.4). These include maternal age below 20 years, lack of antenatal attendance or attendance less than 4 times, delivery assisted by a community member, parity of 2 or more, previous perinatal death, inter-pregnancy interval less than (or equal to) 6 months, and being of the male sex. Factors that appear to be protective are history of having been to school regardless of the level completed, but the difference in perinatal mortality between those babies whose mothers had attended school and those whose mothers had not, was statistically not significant. Delivery by a community member seems to be a high risk for perinatal death, but this result is not significant and must be taken with caution because the sample size in that category is very small (6 cases and 1 control). Home delivery, delivery in a clinic, and primiparity entail risks for perinatal death. However, most of these risk factors prove not to be significant, possibly due to the limitations of the study stated earlier.

4.3.1 Previous perinatal death

The variables with significant results are antenatal visits less than four and especially none at all, and previous perinatal death. These findings are in concordance with findings by investigators in other parts of the world. In Cape Verde, Hans Wessel and colleagues did a

case-control study on risk factors for perinatal mortality and found that previous perinatal death was significantly associated with subsequent perinatal mortality.[18] Similarly, in a population-based study in southern Brazil, C. Barros and other investigators came to the same conclusion when they did a population-based study of perinatal mortality.[27] In India, likewise, Dileep.V. Mavalankar and his colleagues arrived at a similar conclusion when they set out to determine the magnitude and risks associated with perinatal mortality in a hospital-based surveillance and case-control study, linked with a population survey, in Ahmedabad.[19]

4.3.2 Lack of antenatal care

Babies whose mothers have never accessed antenatal care at all stand more than a five-fold risk of experiencing perinatal death when compared with those whose mothers attended antenatal clinic at least four times (Table 3.4). Of women who never accessed antenatal care at all, the odds ratio for total lack of antenatal care increased after adjusting for other factors, which suggests that its independent effect is substantial. This risk decreases as the number of visits increases, with a significant trend. This result is in accord with the findings of other South African studies. Ndiweni and Buchmann conducted a study in Chiawelo Clinic in Soweto and discovered that mothers who did not attend antenatal clinic at all during pregnancy had a six-fold greater risk of perinatal death for their babies.[28] Hamilton and his colleagues came to a similar conclusion following a study at Coronation Hospital in Johannesburg about a decade earlier.[20] This finding is not limited to South Africa, as investigators outside of South Africa have come to similar conclusions.[18,19,29] However, the strength of this study is that it is population-based and therefore not prone to the same biases

as facility-based surveys or research, unlike most perinatal mortality studies carried out in South Africa.

It is therefore quite clear that antenatal clinic attendance impacts positively on pregnancy and neonatal outcome. Antenatal care can be used to deliver interventions essential for newborn babies such as tetanus toxoid vaccination, promoting exclusive breastfeeding, and counseling for birth preparedness (and thereby increasing survivability of the newborn through early detection of potential birth complications).[36] Thus, out in a distant rural setting such as Agincourt, and based on the available evidence, antenatal attendance is probably the most important factor in influencing perinatal mortality because it allows targeting of high risk mothers, such as those with a previous perinatal death, maternal hypertension, and maternal anemia, to name a few. These can be identified during antenatal visits, and steps can then be taken to avert perinatal death, either through controlling those factors or advising the mother to deliver in a place with a level of care able to respond to a potentially poor pregnancy outcome.

It is worth noting that in order for antenatal care to play a significantly role in improving pregnancy outcomes, it must be affordable and equitably accessible to women, and consist of quality interventions (supply), and women must be conscious enough to access it without social, cultural, gender, and other barriers (issues of demand).[37]

Some studies have shown that a program of fewer, well-timed antenatal visits that emphasize specific elements of care during pregnancy, (for example, tetanus toxoid immunization, syphilis screening and treatment, intermittent preventive treatment for malaria, detection and

treatment of asymptomatic bacteriuria, pre-eclampsia and eclampsia prevention using calcium supplementation, metabolic disorders, and previous perinatal death) offer no disadvantage when compared with the conventional 10 to 12 visits usually practiced and advocated worldwide.[30,31,44] Further research in Agincourt or elsewhere in South Africa should address the situation in South Africa, and inform policy on the minimum number of antenatal visits required by pregnant mothers, and the quality of service provided during such antenatal visits, without worsening pregnancy outcomes. .

4.3.3 Birth attendant

Of various potential protective factors, only delivery by a nurse was significant, which, at first glance, seems to contradict the findings of other investigators in the Gambia if one only considers the crude odds ratio.[17] However, following multivariate analysis*, the odds ratio changes substantially, and delivery by a nurse appears to be a risk factor for perinatal death, although this result is not significant, and has a wide confidence interval. This suggests that delivery with a nurse as attendant is not an independent protective factor for perinatal mortality, and that the protective effect that appears to be offered by this variable alone is due to confounding by other factors. This means that, in the absence of other factors that promote positive perinatal outcome, like good antenatal care, intrapartum management and neonatal care, delivery by a nurse in and of itself is not protective for perinatal mortality.

When delivery with a nurse as attendant was taken as reference, delivery with a doctor as birth attendant was a risk factor. This may be because births that are attended by a doctor are

* A statistical procedure which involves observation and analysis of two or more statistical variables (in this case delivery by a nurse, antenatal clinical attendance, intrapartum management, etc.) at one time.

often referrals, or cases that have developed complications that the traditional birth attendants, midwives and nurses cannot handle. These cases are often high risk cases, or arrive at the hospital late in the delivery process so that, despite the technically higher level of care offered by a doctor, in addition to there being better facilities at the district hospital, the mortality rate is higher among such cases.

4.3.4 Independent risk of perinatal death

Knowing that most of these factors are interrelated, multivariate analysis was used to assess the relative independent contribution of each variable (Table 3.5). This resulted in two risk factors, lack of antenatal care and previous perinatal death, remaining significant. The others proved to be statistically insignificant. That the odds ratio increased two-fold for history of previous perinatal death when adjusted for other factors in this study demonstrates that it is a very significant factor for perinatal mortality, and that its true effect is tempered by the presence of other factors such as antenatal care and hospital delivery. Thus a careful history during antenatal visits to identify this risk factor and take appropriate steps to prevent perinatal death cannot be overemphasized.

Parity did not prove to be a significant factor in this study because parity for most mothers at the time of the index pregnancy did not exceed three. In fact, of the 270 study subjects, only 2 had a parity greater than 2 at the time of the index pregnancy. This is consistent with fertility trends in Agincourt over the last decade (1990 to 2000) where the total fertility rate has fallen well below 3.0.[32]

Another important finding was the absence of primiparity as a significant risk factor in this study, unlike what has been observed elsewhere.[17] In fact, a first pregnancy and birth almost become a protective factor. This is probably because 79% of deliveries (178 of 225; 95%CI, 73-84%) by primiparous women occurred within hospitals, thanks to a long-standing health policy in rural settings dating back to missionary days, this researcher was told during a field visit to the Agincourt field site, requiring all first deliveries to be done in hospitals, (71% in hospitals, 5% in clinics, 3% in health centers) where intra- and postpartum care is much better than delivery at home and elsewhere.[45] For instance, of the deliveries occurring outside of health facilities by primiparous women, 63%, (38 of 61; 95%CI, 50-74%) resulted in perinatal death. This is also, it can be concluded, why teenage pregnancy did not prove to be a significant risk factor for perinatal death. Of the primiparous mothers who were less than 20 years old, 83% of them (52 of 63; 95%CI, 71-91%) delivered in health facilities. The long-standing government policy requiring that first deliveries be done in a hospital is a sound one and must be maintained.

Educational level was not demonstrated as an important factor affecting perinatal mortality in this study because, Agincourt being a rural community, the level of public sector health care is fixed for most of the population so that the health care that is available and affordable to the general public is what is provided in the clinics, health centers, and hospitals. Accordingly, it would appear that one's high educational level by itself, and by implication, higher economic income, makes little difference as long as one delivers in public health facilities in Agincourt. One would expect the level of education to positively affect antenatal attendance due to the presumed higher level of awareness of the importance of antenatal care,

and the higher likelihood of educated people to access antenatal services. However, in this study, although a higher percentage of women with some education accessed ANC services (31.4%), than those who had no formal education (28.0%), the difference is not significant; thus level of education is not a significant factor for perinatal mortality in Agincourt sub district.

5.0 Conclusion

This study was undertaken with the aim of quantifying the magnitude of, and risk factors associated with perinatal mortality. It also sought to determine whether perinatal mortality was different for South Africans and former Mozambican refugees in a rural sub-district, and to put forward recommendations potentially relevant to improving the perinatal health of infants. These objectives have been addressed through the use of a case-control study design, appropriate statistical methods, and epidemiological interpretations, all of which draw on the robust longitudinally collected household dataset from the Agincourt field site. This approach, in addition to the consistency of the findings with other studies in South Africa and elsewhere, contribute to the validity[*] of the findings in this study.

This study shows perinatal mortality rate in Agincourt to be 13.4 per thousand births from 1995-2000, and that there is no statistical difference in PMR among South Africans and former Mozambican refugees. Risk factors for PMR are mothers who never attended antenatal clinic at all during the index pregnancy, and mothers who had experienced previous perinatal death of their babies. It is hoped that findings from this study will contribute to the improvement of perinatal health in the Agincourt sub-district and surrounding population, and that lessons learnt can be applied to similar areas of South Africa in particular, and sub-Saharan Africa as a whole.

[*] Whereas the findings from this study are about comparability and generalizability in similar settings, that they are consistent with findings from similar studies elsewhere, speak to the validity of the research, and I wanted that to come out clearly.

In a country with a large poor rural population such as South Africa, health planners and medical practitioners need population-based health information to guide them in the allocation of resources in order to achieve substantial gains resulting from the lowering of perinatal mortality.

5.1 Recommendations

Health provision in Agincourt is free for the patient at the point of (primary care) delivery, with an ambulance available at the health center.[16] Yet, despite this, 21.1% of pregnant women in the study did not access antenatal service at all, and 23.3% delivered in a location other than a health facility (hospital, health center, and clinic).

The following policy-oriented recommendations are made with the hope that they will contribute to the improvement of perinatal health in Agincourt and surroundings, as well as similar rural settings in South Africa. They are organized in three sections to address (i) service delivery issues (supply), i.e., quality of services, availability of trained personnel; (ii) patient factors (demand), i.e., access to available services, which are often influenced by accessibility and affordability; and (iii) further investigation to determine underlying factors and adopt best practice:

5.1.1 Supply factors

1. Effective referral systems be established or strengthened in order to extend and improve the quality of services available at more peripheral primary care level;

2. Peripheral health facilities (clinics and health centers) must be adequately equipped and staffed by professionals trained in the provision of effective antenatal care services, in addition to providing adequate intrapartum and neonatal care;
3. Given the high percentage of non-health facility deliveries, establish or strengthen outreach or community-based care (through community health workers, perhaps?), thereby taking services to the household level, or mobilizing communities to access the services available in health facilities. This has proven effective in other countries in Africa and Asia.[37,39,40]

5.1.2 Demand factors

1. Strategies must be developed to encourage pregnant mothers to attend antenatal clinic and deliver in health facilities (affordability is not an issue, as services are free in Agincourt). Perhaps the child grant or other social security benefits could be conditional on antenatal attendance (as suggested elsewhere)[21] as an incentive to mothers to attend clinic regularly throughout the duration of their pregnancies.
2. Mothers with a history of perinatal death, especially stillbirth, be advised to deliver in hospital because of the higher risk of recurrence of perinatal death in such mothers.

5.1.3 Further research needed

1. Efforts should be made by local health authorities and Agincourt scientific staff to identify reasons why there is not a higher attendance at antenatal clinics despite the

availability of free and reasonably affordable health services in Agincourt and its surrounding regions. As a first step towards that, this research report will be made available to local health authorities in Agincourt with the hope that it will contribute to the reduction of perinatal mortality by stimulating action as well as further research that can inform policy.

2. Research should also be carried out to determine targeted interventions during ANC, with the aim of preventing perinatal deaths.

The need for antenatal care in lowering perinatal mortality rate cannot be overemphasized. It is only during antenatal visits that many mothers receive health education and screening for high risk conditions such as hypertension. Thus antenatal visits by pregnant women should be encouraged at all levels of the health care delivery system where maternity services are offered. In a rural setting such as Agincourt, this can make all the difference to a woman in determining whether or not her pregnancy results in the delivery of a live healthy baby.

APPENDIX A: Maternity history form

Maternity history form **Census 2005v1.0**

NOTE: This form is to complete the childbirth history of all mothers in the Agincourt study area. Children not listed on the household census form must be included here.

Village:	Household:	Fieldworker:	Date of visit:

Mother name:						Mother ID/seq #:		
Name of child	DOB	M/F	L/S/A	Multiple 1,2,3...	Living (L) / dead (D)	If L: child status	If D, age of death	Comment

Mother name:						Mother ID/seq #:		
Name of child	DOB	M/F	L/S/A	Multiple 1,2,3…	Living (L) / dead (D)	If L: child status	If D, age of death	Comment

Mother name:						Mother ID/seq #:		
Name of child	DOB	M/F	L/S/A	Multiple 1,2,3…	Living (L) / dead (D)	If L: child status	If D, age of death	Comment

M=male	**Child status**	**Age of death**
F=female	V=same village	in days (D) if < 1 month
	A=Agincourt area	in months (M) if > 1 month
L=live birth	B=BBR area	in years (Y) if > 1 year
S=still birth	E=elsewhere	
A=abortion		

APPENDIX B: Pregnancy outcome form

Pregnancy outcome form **Census 2005v1.0**

Village:	Household:	Fieldworker:	Date of visit:

Mother

Mother ID:	Mother surname:	First name:
Antenatal clinic:	Y – Yes; N – No	If yes, no. antenatal visits:
Education:	N – None; A – Sub A; B – Sub B; 1 – Std 1; 2 – Std 2; 3 – Std 3; 4 – Std 4; 5 – Std 5; 6 – Std 6; 7 – Std 7; 8 – Std 8; 9 – Std 9; 0 – Std 10; H – Higher	
Scholar:	Y – Yes, N - No	If Yes, back to school? Y – Yes; N – No; I – Intend to
Pregnancy planned:	Y – i.e.; N – No; O – Other	
Contraception before:	N – None; P – Pill; I – Injection; L – Loop; C – Condom; S – Sterilisation; T – Traditional; M – More than one	
Contraception after:	N – None; P – Pill; I – Injection; L – Loop; C – Condom; S – Sterilisation; T – Traditional; M – More than one	

Delivery

Date of delivery:	DOB estimated:	Y – Yes; N – No
Delivery in Agincourt area:	Y – Yes; N – No	
Delivery place:	H – Home; C – Clinic; N – health centre; + - hospital; O – Other	
If hospital:	T – Tintswalo; MP – Mapulaneng; MT – Matikwane; RF – Rob Ferreira; PM – Pietersburg-Mankweng; O – Other	
Attendant:	D – Doctor; N – Nurse; F – Family member; C – Community member; B – Nobody; O – Other	
Complication at delivery:	N – none; C – caesarian section; O – other	
If other complication, type:		

Outcome

If single delivery, outcome:		L – Live birth; S – Stillbirth (28 weeks or more); A – Abortion (less than 28 weeks);
If multiple delivery:	Number stillbirths:	
	Number live births:	
Duration of pregnancy:		In months (M) and/or weeks (W)
Baby's surname:		

Baby name:	Gender M/F	Birthwt (kg):	Road To Health (Y-Yes; N – No; E -Elsewhere)	Ever breastfed Y / N	If yes, how long: B – still breastfeeding; No. W if <1mo; no. M if >1mo	Birth registered: Y/N

REFERENCES

1. African National Congress. *A national health plan for South Africa*. Johannesburg: African National Congress, 1994
2. Kustner H.G.V., South African Mortality Rates, 1986 to 1989, *Epidemiological Comments.* 1992; 19: pages 24-32
3. World Health Organization. Maternal and child health: regional estimates of perinatal mortality. Weekly. Epidemiological Record, 1989; 64 (24) 184-186
4. Thomson, A. M., and Barron, S. L., Perinatal Mortality. In: Barron, S. L., Thomson A. M., ed. *Obstetrical Epidemiology*. London, Academic Press, 1983, pages 346-398
5. Chamberlain, G. Better perinatal health: background to perinatal health. *The Lancet*, 1979; 2: 1061-1063
6. Erkin M., Randomised controlled trials in the evaluation of antenatal care. *International Journal of Technology Assessment in Health Care 1992; 8:33-39.*
7. Watts, T., Harris, R. R., A case-control study of stillbirths at a teaching hospital in Zambia, 1979-80: antenatal factors. *Bulletin of the World Health Organization*, 60: 971-979 (1982)
8. Ferraz, E. M., Gray, R. H., A case-control study of stillbirths in North-east Brazil. *International Journal of Gynecology and Obstetrics*, 34: 13-19 (1991)
9. Pattinson R C. Saving babies: a perinatal care survey of South Africa. *Science in Africa. www.scienceinafrica.co.za/2001/july/babies.htm*
10. Buchmann E. J., Grofton Briggs I. G., McIntyre J. A., Previous birth outcome of antenatal clinic attendees in northern KwaZulu-perinatal and infant mortality rates. *South African Medical Journal* 1992; 81:419-421
11. Odendaal H. J., Theron G. B., Norman K., Steyn D. W., de Jong G., Geerts

L. et al. Towards reducing perinatal deaths in South Africa. Policy brief No.5 September/October 1997

12. Ross S. M., Macpherson T. A., Naeye R. L., Khatree M. H. D., Wallace J. A., Causes of fetal and neonatal mortality in a South African Black community. *South African Medical Journal* 1982; 61: 905

13. Dommisse J., The causes of perinatal deaths in the Greater Cape Town area. *South African Medical Journal* 1991; 80: 270-27

14. Collinson M., Mokoena O., Mgiba N., Kahn K., Tollman S., Garenne M., et al. Agincourt DSS, South Africa. In: Sankoh O. A., Kahn K., Mwageni E., Ngom P., Nyarko P, editors. Population and Health in Developing Countries, volume 1. International Development Research Centre 2002: 197-206

15. Tollman S M. The Agincourt Field Site-Evolution and current status. *South African Medical Journal* 1999; 89: 853-858

16. Tollman S. M., Herbst Kobus, Garenne M., Gear J. S. S., Kahn K., The Agincourt demographic and health study-site description, baseline findings and implications. *South African Medical Journal* 1999; 858-864

17. Leach A., McArdle T. F., Banya A. S., Krubally O., Greenwood A. M., Rands C., et al. Neonatal mortality in a rural area of The Gambia. *Annals of Tropical Pediatrics* 1999; 19, 33-43

18. Wessel H., Cnattingius S., Dupret A., Reitmaier P., Risk factors for perinatal death in Cape Verde. *Paediatric and Perinatal Epidemiology* 1998; 25-36

19. Mavalankar D. V., Trivedi C. R., Gray R. H., *Bulletin of the World Health Organization, 1991;* 69 (4): 435-442

20. Hamilton R. A., Perlmann T., de Souza J. J. L., The unbooked patient. *South African Medical Journal* 1987; 71: 28-31

21. Adhikari M., Pillay K., Gouws E, Moodley D., Desai P. K., Moodley J., Trends in perinatal mortality at a teaching hospital: implications for resource allocation. *International Child Health*, vol. VI, No. 3, July 1995
22. South African Health Review 2000. Published by the Health Systems Trust 2000
23. Duarte G., Quitana S. M., Mussi-Pinhata M. M., et al. Impact of maternal HIV-infection on obstetrical and early neonatal outcome: a nine-year experience (abstract). XI International Conference on AIDS, Vancouver, British Colombia, Canada, June, 1996: Tu.C.2572
24. Guay L., Mmiro F, Ndugwa C. et al. Perinatal outcome in HIV-infected women in Uganda (abstract). VI International Conference on AIDS, San Francisco, California, USA, June 1990: TH.C.42.
25. Brocklehurst P., French R., The association between maternal HIV infection and perinatal outcome: a systematic review of the literature and meta-analysis. *British Journal of Obstetrics and Gynaecology;* August 1998, vol. 105 pages 836-848
26. Karmi G., (editor). Refugees and The National Health Service, a report of the health and ethnicity programme of North East Thames Regional Health Authority and North West Thames Regional Health Authority, London, 1992.
27. Barros C., et al. Perinatal mortality in southern Brazil: a population-based study of 7392 births. *Bulletin of the World Health Organization*, 1987; 65: 95-105
28. Ndiweni Q., Buchmann E. J., Unbooked mothers and their babies-what causes the poor outcomes? *South African Medical Journal* 1998; 88:192-199
29. Bhatia B. D., et al. A study of perinatal mortality rate from a rural-based medical college hospital. *Indian Journal of Pediatrics,* 1984; 51: 165-171

30. Villar J., Ba'aqeel H., Piaggio G., Lumbiganon P., Belizan J. M., Farnot U., et al. WHO antenatal care randomized trial for the evaluation of a new model of routine antenatal care. *The Lancet*, Vol. 357. May 19, 2001

31. Bergsjo P., Villar J., Scientific basis for the content of routine antenatal care: II, power to eliminate or alleviate adverse newborn outcomes; some special conditions and examinations. *Acta Obstetricia et Gyneacologica Scandinavica*, 1997; 15-25

32. Garenne M., Tollman S. M., Generation gaps: rapid fertility decline in a rural area of South Africa (Agincourt). Population Association of America Annual Meeting, New York, March 1999 (poster presentation).

33. Lawn J. E., Cousens S., Zulfiqar, A., Darmastadt G. L.,Martines J., Vinod P., Knippenberg R., Fogstad H., for the Lancet Neonatal survival Steering Team Neonatal Survival 1: 4 million neonatal deaths: when? Where? Why? *The Lancet* 5 March 2005; Vol. 365, Issue 9462, pages 891-900

34. Lopez A. D., Mathers C. D., Ezzati M., Jamison D. T., Murray C. J. L., Global and regional burden of disease and risk factors, 2001:systematic analysis of population health data. *The Lancet*, 2006; 367, 1747-57

35. National Research Council (2002) *Leveraging Longitudinal Data in Developing Countries: Report of a Workshop*. Workshop on Leveraging Longitudinal Data in Developing Countries Committee, Committee on Population. Valerie L. Durrant and Jane Menken, editors. Division of Behavioral and Social Sciences and Education. Washington, DC: National Academy Press.

36. Martines J., Vinod K. P., Bhutta Z. A., Koblinsky M., Soucat A., Walker N., Bahl R., Fogstad H., Costello A., for the Lancet Neonatal Survival Steering Team.

Neonatal Survival: a call for action. *The Lancet* 26 March 2005; Vol. 365, Issue 9465, pages 1189-1197.

37. Knippenberg R., Lawn J. E., Darmstadt G. L., Begkoian G., Fogstad H., Walelign N., Vinod P., Cousens S., Bhutta Z. A., Marines J., for the Lancet Neonatal Survival Steering Team. Systematic scaling up of neonatal care in countries. *The Lancet* 19 March 2005; 365:1087-1098

38. Saving Babies: A Perinatal Care Survey of South Africa 2000. compiled by the Medical Research Council Unit for Maternal and Infant Health Care Strategies, PPIP Users, and the National Department of Health

39. Koblinsky M. A., Campbell O., Heichelheim J., Organizing delivery care: what works for safe motherhood: *Bulletin of the World Health Organization* 1999: 77:399-406.

40. Ronsmans C., Endang A., Gunawan S., Zazari A., McDermott J., Koblinsky M., Marshall T., Evaluation of a comprehensive home-based midwifery programme in South Kalimantal, Indonesia. *Tropical Medicine & International Health* 2001; 6: 799-810.

41. Hargreaves J. R., Collinson M. A., Kahn K., Clark J.C., Tollman S. M., Child mortality among former Mozambican refugees and their hosts in rural South Africa. *International Journal of Epidemi*ology 2004 33(6):1271-1278.

42. Zupan J., Aahman E., Perinatal mortality for the year 2000: estimates developed by WHO, Geneva: World Health Organization, 2005

43. HIV and AIDS statistics for South Africa: www.avert.org/safricastats.htm, 2008

44. Darmstadt G. L., Bhutta Z., Cousens S., Adam T., Walker N., Bernis L., for the Lancet Neonatal Survival Steering Team, Evidence-based cost-effective interventions: how many newborn babies can we save? *The Lancet* 12 March 2005 Vol. 365, Issue 9463, pages 977-988

45. Garenne M., Tollman S. M., Kahn K., Collins T., Ngwenya S., Understanding marital and premarital fertility in rural South Africa. *Journal of Southern African Studies,* Volume 27, Issue 2, June 2001, pages 277-290

46. Travis P., Bennett S., Haines A., et al. Overcoming health-systems constraints to achieve the Millennium Development Goals. *The Lancet* 2004; 364: 900-06.

47. WHO. Making pregnancy safer: the critical role of the skilled attendant: a joint 4statement by the WHO, ICM and FIGO. Geneva: World Health Organization, 2004.

48. World Bank. The World Development Report 2004: Making services work for the poor. Washington: The World Bank, 2004.

49. Lawn, J. E., Gravett, M. G., Nunes, T. M., Rubens, C. E., Stanton, C. and the GAPPS Review Group. Global report on preterm birth and stillbirth (1 of 7): definitions, description of the burden and opportunities to improve data

50. District Health Barometer. Massyn N., Day C., Barron P, Haynes R., English R., Padarath A, 2013